

1 TO WHOM IT MAY CONCERN:

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3 BE IT KNOWN THAT I, DAVID W. WARREN, a
4 citizen of the United States of America, residing in
5 Glendale, in the County of Los Angeles, State of
6 California, have invented a new and useful improvement
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10 COMPACT ENDOTHERMIC CATALYTIC

11 REACTION APPARATUS

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1 **BACKGROUND OF THE INVENTION**

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3 This application is a continuation-in-part of
4 Serial No. 09/687,098 filed October 16, 2000.

5 This invention relates to the use of
6 endothermic catalytic reaction apparatus operable to
7 produce hydrogen-containing gases from hydrocarbon
8 feedstock.

9 Endothermic catalytic reaction apparatus,
10 for converting hydrocarbon feedstock to hydrogen-rich
11 gases, is well known in the art. Commercial
12 production of hydrogen is commonly achieved by a
13 process known as steam reforming, that involves the
14 endothermic reaction between a mixture of hydrocarbon
15 feedstock and steam passed through a catalyst filled
16 reactor tubing that is heated.

17 In commercial steam reformers for large-
18 scale production of hydrogen from hydrocarbon feeds,
19 endothermic heat is commonly supplied by the
20 combustion of carbonaceous fuel and oxidant in a
21 diffusion or turbulent flame burner that radiates to
22 the refractory walls of a combustion chamber, thereby
23 heating them to incandescence, and providing a radiant

1 source for heat transfer to a tubular reaction
2 chamber. Uniform radiation to the surfaces of the
3 tubular reaction chamber is essential since excessive
4 local overheating of the tube surface can result in
5 mechanical failure. In large-scale commercial steam
6 reformers, mal-distribution of heat within the furnace
7 chamber is minimized by providing large spacing
8 between the individual reactor tubes, the furnace
9 walls, and the burner flames. However, for small-
10 scale catalytic reaction apparatus that is uniquely
11 compact, such as for the production of hydrogen for
12 small fuel cell applications, special design features
13 are needed to prevent tube overheating.

14 U.S. Patent 4,692,306 to Minet and Warren
15 describes a compact reformer comprising an annular
16 reaction chamber concentrically disposed around an
17 internal burner chamber containing a vertically
18 disposed cylindrical radiant burner that uniformly
19 radiates in the radial direction. A uniform radiation
20 pattern to a concentrically disposed annular reaction
21 chamber that surrounds the radiant burner, is
22 provided, thereby avoiding the problems with flame
23 impingement and local overheating of tube surfaces